troversial matter. Rules for experimental and introspective research and illustrations of their application are arranged and expounded in a thoroughly methodical manner. The author admits only two ultimate kinds of "conscious elements"—sensation and affection—definitely rejecting *activity* as a third conscious element. Space is devoted to what may be called "Numeral Psychology," *i.e.* the estimate of the total number of different conscious elements. The method, of course, is to ascertain the just discriminable difference. Underlying this whole procedure there appears to be a logical fallacy, or at least a difficulty which modern text-books entirely ignore. Thus, suppose that *a*, *b*, *c*, *d*, *e*, *f* . . . is a series of measurably different physical stimuli, and A, B, C, D, E, F . . . the sensation-processes supposed to correspond with the stimuli. Suppose, further, that *a*—*d* or A—D represents the just discernible difference. Then, by hypothesis, sensation A *is* just distinguishable from sensation D, while sensation B is *not* just distinguishable from sensation D. Hence sensations A and B have opposite predicates, and therefore they are different, although, by hypothesis, they are consciously undistinguishable. Now in "counting" the number of sensation-elements, it is always assumed that difference means the same as distinguishableness. But that this leads to logical contradiction is obvious from the above, while it is in flat opposition to Weber's logarithmic formula, which implies that a continuous variation of stimuli corresponds to a *continuous*—not discrete—variation of sensation. The author's mode of distinguishing (1) sensation, whether peripherally or centrally aroused, (2) perception or idea, and (3) the association of ideas, seems decidedly original and worthy of careful consideration. No doubt he is right in making the distinction between (1) and (2) depend on the absence or presence of objective significance; but it seems unsatisfactory to offer only a "biological reason" (p. 183) for the unity possessed by the perceptual or ideal complex of sensations. Again, in treating of conception, judgment and reasoning, no higher mode of intellection seems to be recognised than association. We feel ourselves carried back to the dark ages of psychology when we read (p. 301)—

> "We speak of a comparison of two impressions when the ideas which they arouse in consciousness call up the verbal associate 'alike' or 'different.' . . . We have in this process of comparison or discrimination, then, a case of verbal association."

We are curious to know whether the words "alike" or "different" have any significance; and, if so, whether this significance is an object of conscious apprehension or not. Other passages point to similar defects, owing to the author's confidence in sensation and association as the sufficient materials for all intellectual processes. It is true that the author avoids many of the fallacies of the old mechanical view of association, and many parts of his exposition are unexceptionable in the light of modern criticism. But the characteristics of the book that are to be most highly commended are clearness, simplicity, wealth of illustration, and, in general, adaptation to the needs of the beginner who requires to be placed *en rapport* with the latest results of experimental psychology.

W. E. JOHNSON.

## *A MANUAL OF DAIRY WORK.*

*The Book of the Dairy.* Translated from the German of W. Fleischmann by C. M. Aikman and R. P. Wright. Pp. xxiv + 344. (London: Blackie and Son, 1896.)

NO branch of practical agriculture has made greater progress during the last quarter of a century than that which may be broadly described as dairy farming. The evidences of this advance are to be sought, however, not so much in the operations antecedent to the production of milk as in the processes employed in its after treatment. In making this assertion, we do not overlook the improvements which dairy farmers have effected in the housing, feeding, and general management of milch kine. But these have resulted mainly from the intelligent modification of time-worn practices, whereas in the manipulation of milk, either for sale as such, or for manufacture into butter or cheese, there has been ample scope for modern ingenuity in the introduction of novel methods. The cow remains to-day what she has been for ages—a physiological implement for the production of milk, and we may recall the words of Charles Dickens, "If civilised people were ever to lapse into the worship of animals, the Cow would certainly be their chief goddess." Cows, especially of certain breeds, have, by judicious selection exercised by the breeder, been greatly improved in their milk-yielding capacity, in respect both of quantity and of quality. But there is no essential distinction between the cows of to-day and those which furnished milk to our Saxon ancestors—the difference is only one of degree. On the other hand, the change in the methods and appliances of the dairying industry, even if the comparison be made with so recent a period as only thirty years ago, is so profound that it may well be termed revolutionary. The displacement of the old system of cream-raising by the rapid work of the centrifugal separator, the rational use of micro-organisms in the ripening of cheese, the sterilisation of milk in the destruction of tuberculous and other germs, the direct and almost instantaneous manufacture of butter from fresh milk, are only a few illustrations of what has been accomplished in very recent years. With such changes constantly in progress an extensive literature has sprung up around the industry of dairying, and many notable works upon the subject have been published in the English, French, German, and Danish languages.

Of the dairying experts of Germany, no one occupies a higher position than Dr. Fleischmann, of Königsberg, and no doubt many readers will welcome an English translation of his well-known manual of the science and practice of dairy work, which Messrs. Blackie have issued in a style deserving of commendation. The first chapter deals with the secretion, properties, and composition of milk, and discusses the defects which give rise to bitter, coloured, ropy, lazy, or sandy milk. The extraction, immediate sale, and testing of milk form the subject of the next chapter, which is partly commercial in its scope. For the third chapter the translators have chosen the not very intelligible title of "Milk in its relation to micro-organisms, dairying, and bacteriology." Butter-making and cheese-making are the respective subjects of the two succeeding chapters, which are

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followed by one on the "Preparation of keeping milk, fermented milk, and the bye-products of milk." The economic aspects of dairying are next dealt with, and a concluding chapter is devoted to margarine and margarine cheese.

The definition of milk, with which the book opens, seems to lack those qualities of precision which should characterise a definition. What kind of notion would the following words convey to a reader who knew nothing about milk?—

"By milk, in the widest sense of the term, is understood the secretion of the special glands of the female mammal. It is a white, opaque liquid, of the character of an emulsion, with a faint odour and a slight flavour; and it is produced during a longer or shorter period after parturition. It consists chiefly of water, fat, casein, albumin, milk-sugar, and mineral salts, and is specially adapted for the sustenance of the young."

That milk "consists chiefly of water" we know; but had the translators been on the alert, they would have suppressed the word "chiefly" in the foregoing passage. The difficulties of translation, indeed, are exemplified in various unhappy phrases, as, for instance, when keeping milk is defined as milk which "possesses the property of being able to keep."

A point about which there has been much controversy —the existence or not of an enveloping membrane upon each of the fat globules in milk—is dealt with emphatically enough:—

"The fat globules are not surrounded with a membranous envelope. Owing to the action of molecular force, the little globules are surrounded by a thin watery covering of serum, and act very much as if they were actually surrounded by a membrane."

Dairy farmers, and many who are not dairy farmers, will be puzzled by a statement, which apparently has been casually dropped in on p. 21, concerning the impetus which a globule receives through its weight and centrifugal force; there is at least novelty in the idea of the "centrifugal force" of a fat globule of milk. On p. 46 is another statement which will certainly startle all experienced feeders of dairy cattle; it is to the effect that "milk cows must not be fed with beans, peas, lupines, pea-straw." Of feeding with lupines we do not know much in this country; but as to the other materials, a footnote shows that even the translators felt uneasy, and it is regretable that they did not suppress the passage. The author recommends, in the winter feeding of butter cows, the moderate use of beet, in conjunction with other foods. This, of course, is perfectly intelligible to a German farmer; but the translators should have added that for all practical purposes the English mangel is competent to take the same place in the food as the German beet. The feeding of cows, indeed, is a subject which might well have been treated more fully. This section contains a statement which we cannot forbear quoting, for it relates to a matter of as much practical interest to the dairy farmer as of scientific interest to the physiologist. On p. 42, the author says:—

"There can be no doubt that, in the case of cows yielding a large amount of milk, the fat derived from the food is utilised for the formation of milk-fat."

The nature of the few criticisms we have made should render it obvious that a free translation and adaptation of Fleischmann's work would have been more valuable than the very literal translation that has been provided. Many of the woodcuts—of which there are eighty-five, besides half-a-dozen full-page plates—are different from those in the German original, and it is matter for regret that the same latitude was not allowed in connection with the text. It cannot be doubted that the translators possess the knowledge and skill essential to the production of a serviceable adaptation, and their description of—for example—the manufacture of Cheddar cheese in this country would probably have differed considerably from that of which they have laboured hard to furnish a word-for-word rendering. Viewing the book as a whole, it is not one to put into the hands of a beginner. A discriminating reader, however, who already possessed some knowledge of the subject, would peruse its pages with profit.

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## *OUR BOOK SHELF.*

*Elementary Geology.* By G. S. Boulger, F.L.S., F.G.S. Pp. viii + 180. (London and Glasgow: William Collins, Sons, and Co., Ltd., 1896.)

DR. W. S. DAVIS' "First Book of Geology" has been rewritten and revised throughout, and transformed by Prof. Boulger into the text-book now under notice. The chief criticism we have to offer upon this metamorphosed volume—and the criticism applies to most elementary text-books—is that details are dealt with much too early. Four pages in the present volume are devoted to general remarks on the objects and methods of geology, geological evidence, and divisions of the subject; and about five pages to descriptions of the form and size of the earth, terrestrial movements, the nebular theory, the probable condition of the interior of the earth, and the cause of the Glacial period. The nature of the descriptions may be gathered from the statement of the limited space occupied by them. Of this brief treatment of large subjects we do not, however, enter a complaint, for the book is intended principally for pupils connected with the Department of Science and Art, and, regretfully though we say it, these pupils like concentrated essence of facts, which can be assimilated with the smallest possible mental exercise. Such readers may develop a mild kind of interest in the first nine pages of the book; but then comes the *pons asinorum* of text-book geology—the account of rock-forming minerals and their distinctive characters. Why should such a paragraph as the following be put before a beginner in geology?

"Sulphur unites with many metals to form *sulphides*, including the abundant iron-pyrites ($FeS_2$), and many important metallic ores, such as chalcopyrite, galena, and blende, ores of copper, lead, and zinc respectively. Chlorine with sodium forms the abundant *chloride*, common salt ($NaCl$). Iron forms two oxides, the *ferric oxide* ($Fe_2O_3$), which occurs as hæmatite and hydrated as limonite, both important ores, and the *ferrous oxide* ($FeO$), while both occur in the black oxide, magnetite ($FeO$, $Fe_2O_3$, or $Fe_3O_4$). The oxide of aluminium ($Al_2O_3$) is called *alumina*; that of calcium ($CaO$), *lime*; that of sodium ($Na_2O$), *soda*; that of potassium ($K_2O$), *potash*; and that of magnesium ($MgO$), *magnesia*; and these oxides and those of iron are, when in combination, known as *bases*. In combination with acids they form *salts*; with silicic acid ($H_2SiO_3$), silicates; with carbonic acid ($H_2CO_3$), carbonates; with sulphuric acid ($H_2SO_4$), sulphates. The majority of rock-forming minerals are silicates."

It seems to us to be a great mistake to assume that young students of geology possess sufficient know-

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